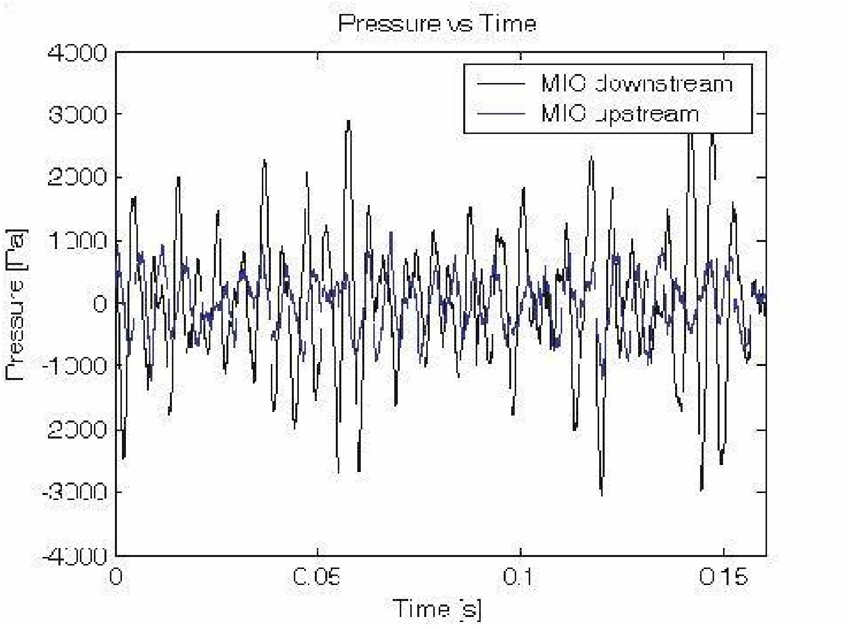
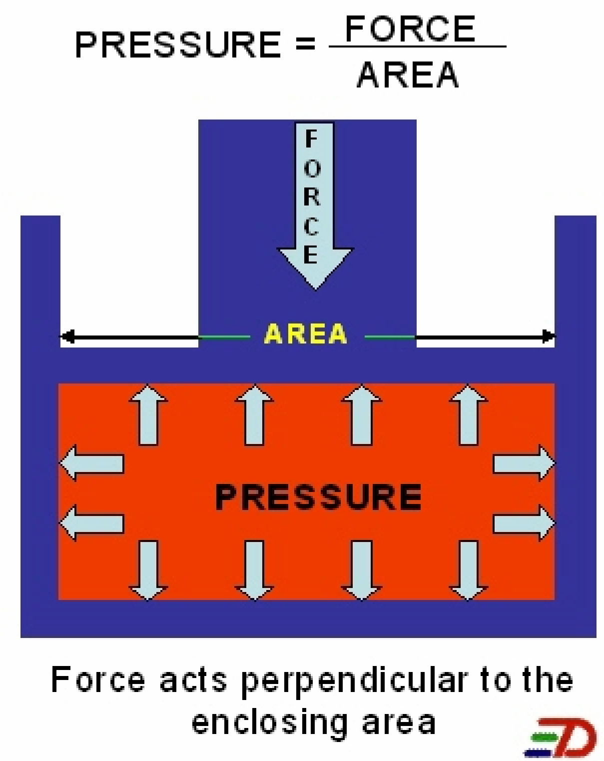
Introduction

Pressure measurement may be divided into two groups:

a. The measurement of a static pressure.

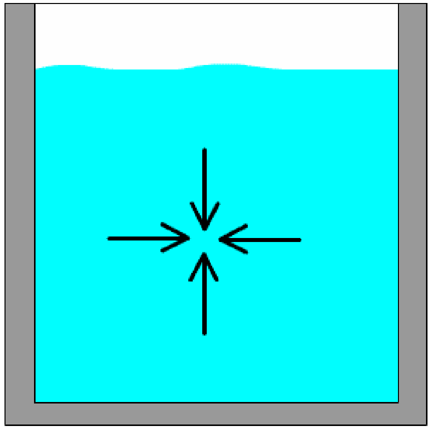
b. The measurement of a fluctuating pressure



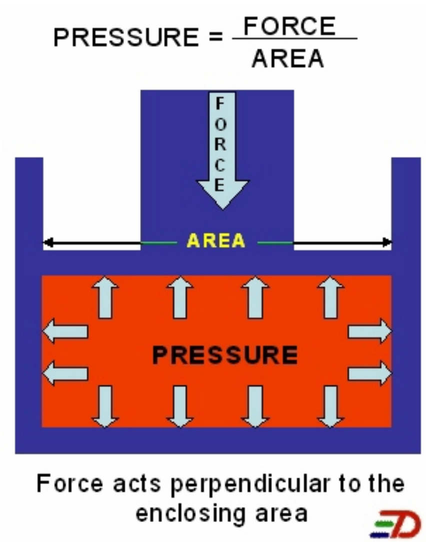


Principles of Pressure Measuring Devices

1. The pressure is strongly influenced by position within a static fluid, but at a given position it is quite independent of direction (principle being employed in manometers).



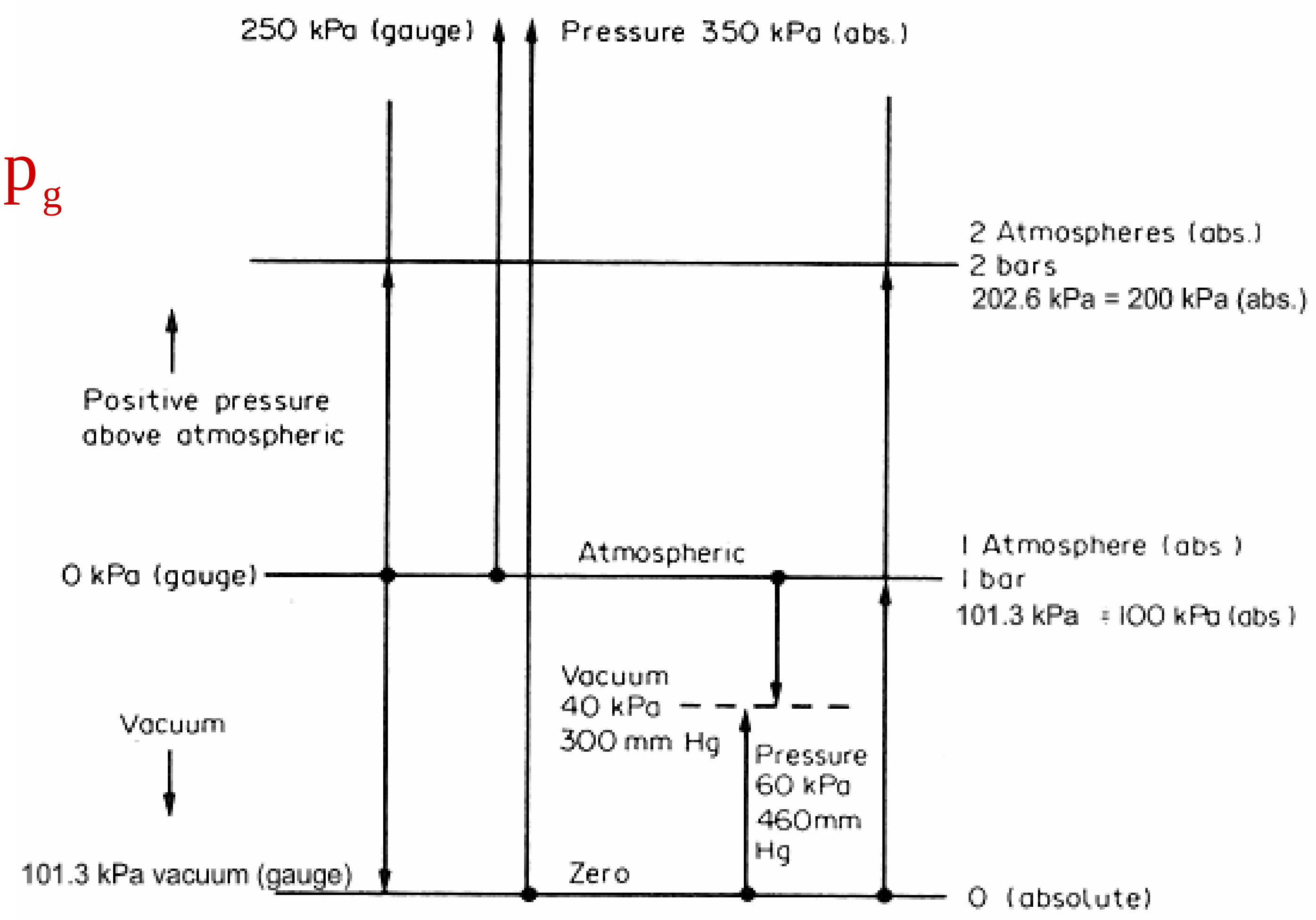
2. Pressure is unaffected by the shape of the confining boundaries therefore a great variety of fluid pressure transducers is available.



3. Pressure applied to a confined fluid through a movable surface is transferred undiminished throughout the fluid to a bounding surface; a principle employed in dead–weight testers.

Static Pressure Measurement

$$p_{abs} = p_{atm} + p_g$$



Differential Pressure Measurement

Devices for differential pressure measurement

1. Manometers
   - Simple U-tube manometer
   - Industrial U-tube manometer
   - The Cistern manometer
   - The two-liquid U-tube manometer
   - The inclined manometer
2. The ring balance
3. Diaphragms & bellows Gauges
   - Single diaphragm
   - Diaphragm stack
   - Metallic capsule
   - Metallic bellows

The Simple U-Tube Manometer

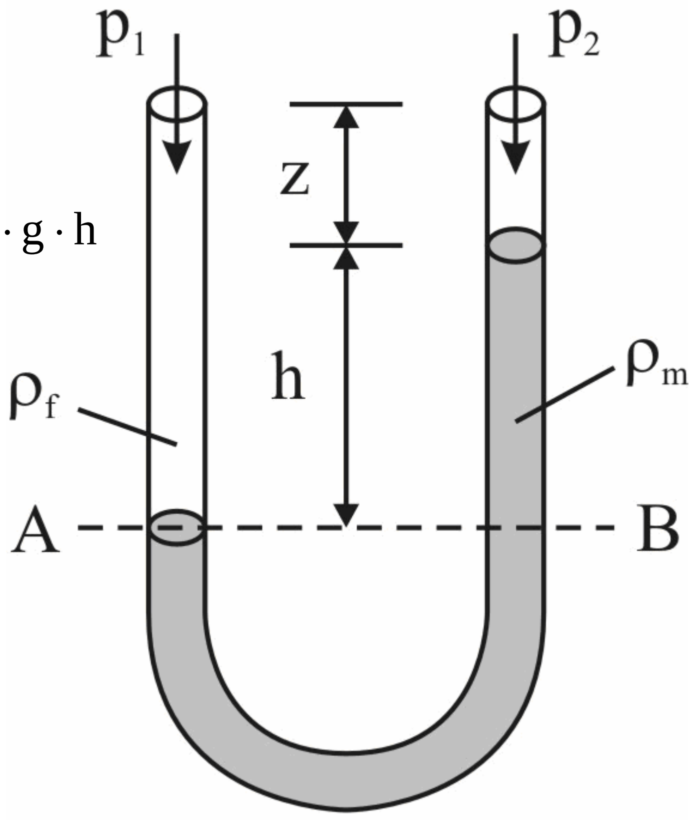
$$p_A = p_B$$

$$p_1 + \rho_f \cdot g \cdot (z + h) = p_2 + \rho_f \cdot g \cdot z + \rho_m \cdot g \cdot h$$

$$p_1 - p_2 = \rho_m \cdot g \cdot h - \rho_f \cdot g \cdot h$$

$$p_1 - p_2 = \Delta p = \rho_m \cdot g \cdot h$$

$$\boxed{\sigma_{u-Tube} = \frac{dh}{d\,\Delta p} = \frac{1}{\rho_m \cdot g}}$$



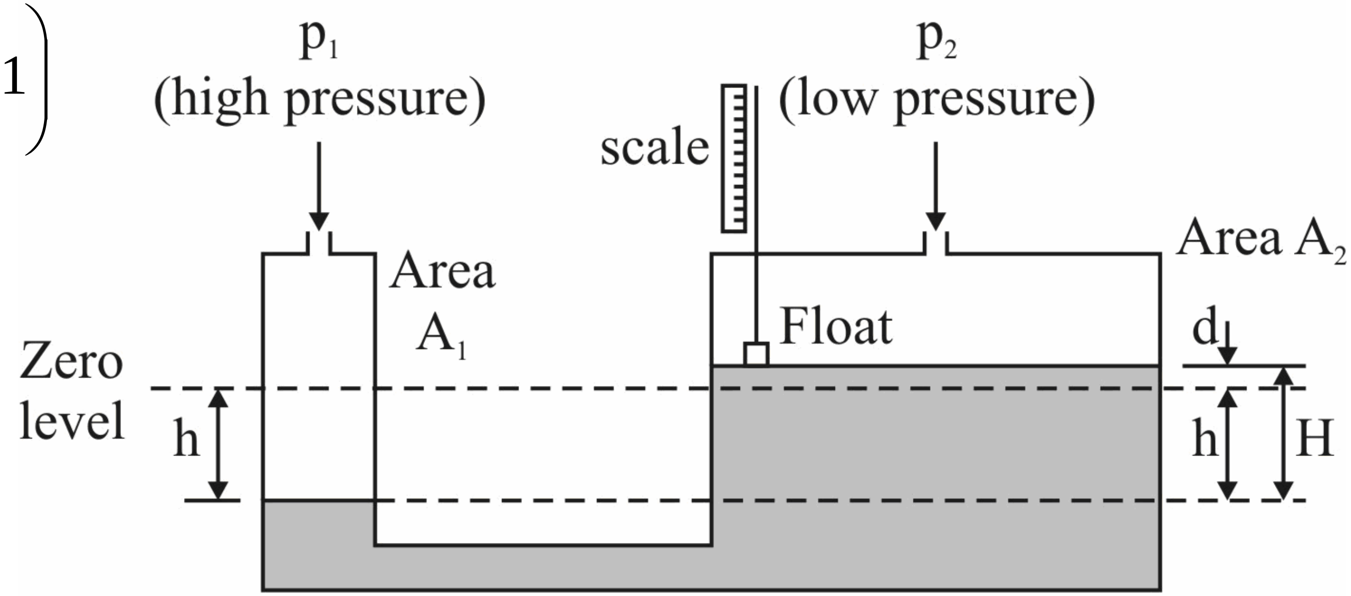
The Industrial U-Tube Manometer

$$p_1 = p_2 + \rho g H = p_2 + \rho g (h + d)$$

$$A_1 \cdot h = A_2 \cdot d \longrightarrow h = \frac{A_2}{A_1} \cdot d$$

$$p_1 - p_2 = \rho g d \left(\frac{A_2}{A_1} + 1 \right)$$

$$\boxed{d = \frac{(p_1 - p_2)}{[\rho g (A_2 / A_1 + 1)]}}$$



The Cistern Manometer

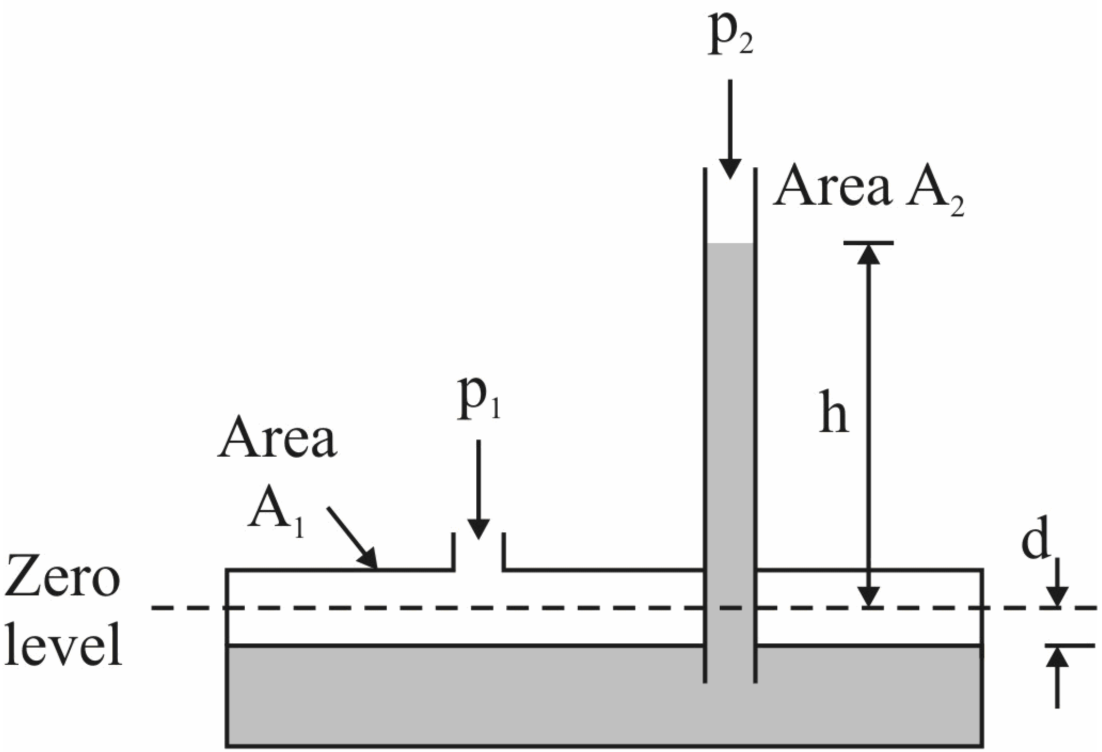
$$p_1 - p_2 = \rho g \left(h + d\right)$$

$$A_1 \cdot d = A_2 \cdot h \longrightarrow d = \frac{A_2}{A_1} \cdot h$$

$$p_1 - p_2 = \rho g h \left(1 + \frac{A_2}{A_1}\right)$$

If the value of A2/A1 is so small that it may be neglected then

$$p_1 - p_2 = \rho g h$$



The Inclined Tube Manometer

$$p_1 - p_2 = \rho g \left(h_1 + h\right)$$

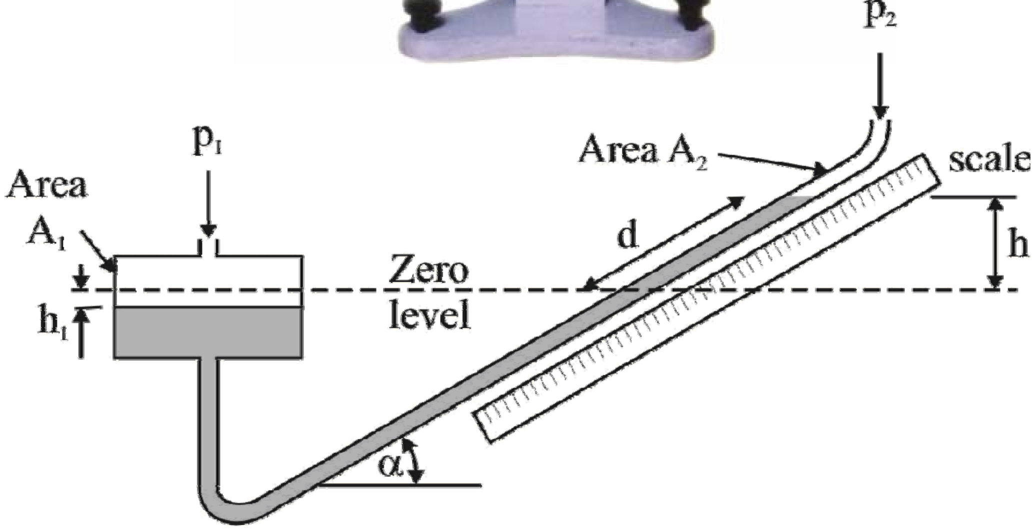
$$h = d \sin\alpha$$

$$h_1 = \frac{A_2}{A_1} \cdot d$$

$$p_1 - p_2 = \rho g d \left(A_2/A_1 + \sin\alpha\right)$$

If A1 is large compared with A2

$$p_1 - p_2 = \rho g d \cdot \sin\alpha = \rho g h$$

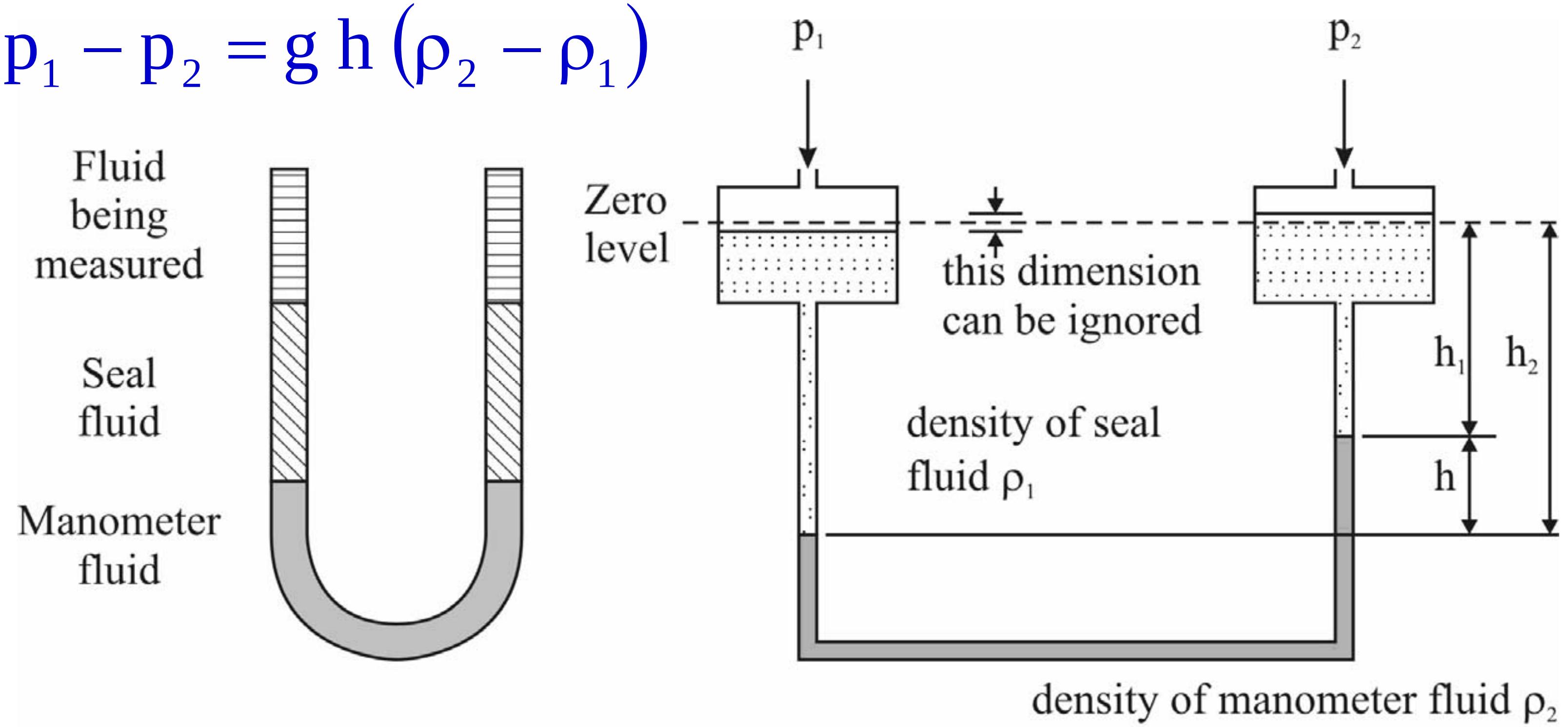


$$S_{\text{inc. man.}} = \Delta\text{output}/\Delta\text{input} = d(d)/d(p_1 - p_2) = 1/(\rho g \cdot \sin\alpha)$$

The Two Liquid U-Tube Manometer

It may be necessary to separate the liquid from the manometer liquid by using a sealing fluid. For example, if the two liquids react when mixed so seal fluid is required.

$$p_1 - p_2 = g\,h\,(\rho_2 - \rho_1)$$

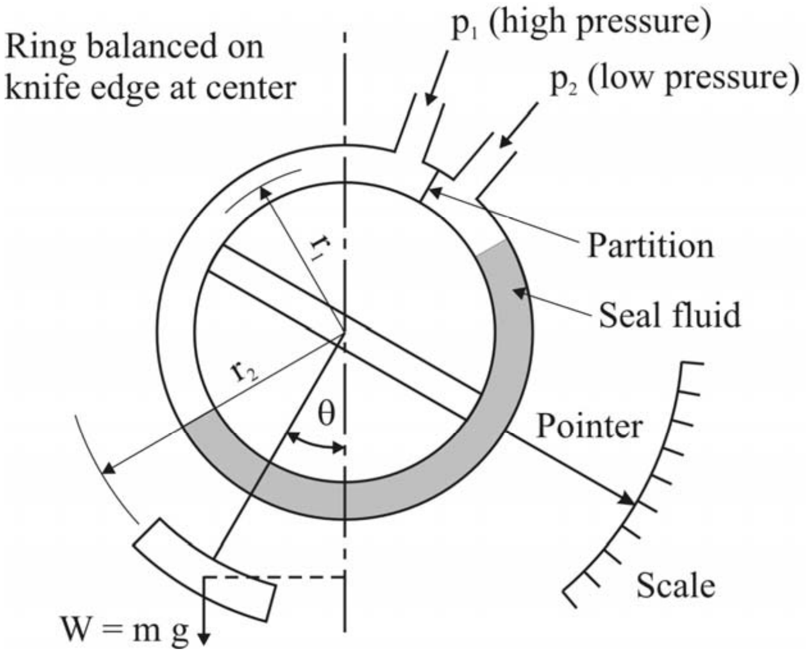


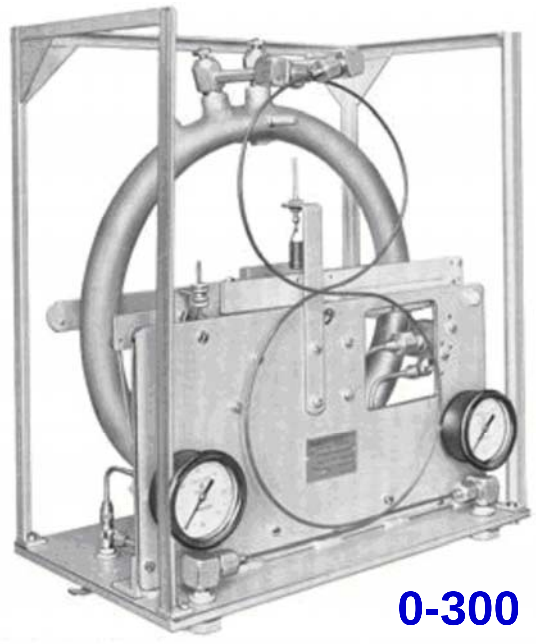
The Ring Balance

It is usually employed for low differential pressure.

$$\text{Rotating moment} = (p_1 - p_2) \cdot A \cdot r_1 \qquad \text{Restoring moment} = (m\,g) \cdot r_2 \cdot \sin\theta$$

$$p_1 - p_2 = \frac{m\,g \cdot r_2}{A \cdot r_1} \cdot \sin\theta$$





0-300 mm water


Thank You!